Components for Coastal Setbacks and Inundation Levels

James Carley

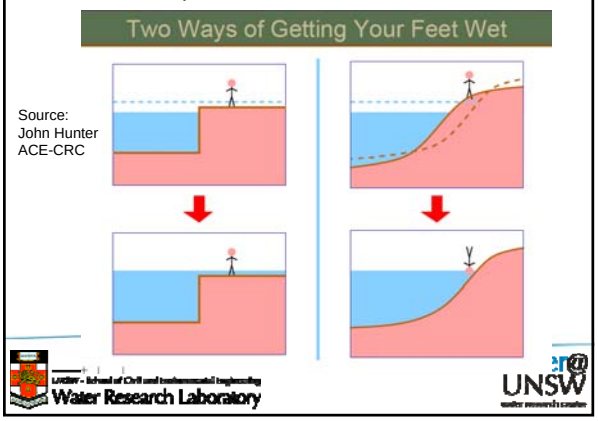
Water Research Laboratory
School of Civil and Environmental Engineering
University of New South Wales

Water Research Laboratory (UNSW)

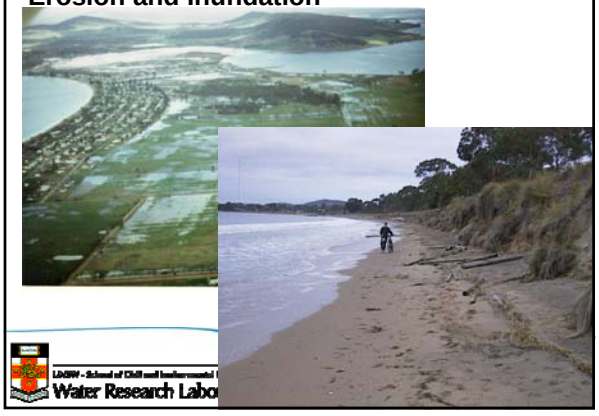
- Private Campus since 1959.
- 50+ Engineers & Scientists
- Applied Research
- Physical & Numerical Models
- Field Work

GEOS 3014
GIS in Coastal Management

Coastal erosion,recession and inundation



Erosion and Inundation



Extreme events and design event

Encounter probability or a PDF is more correct, but...

BUILDING CODE OF AUSTRALIA (2007) For private house:
Wind load: 500 yr ARI; Water entry: 100 yr ARI; Earthquake: 500 yr ARI

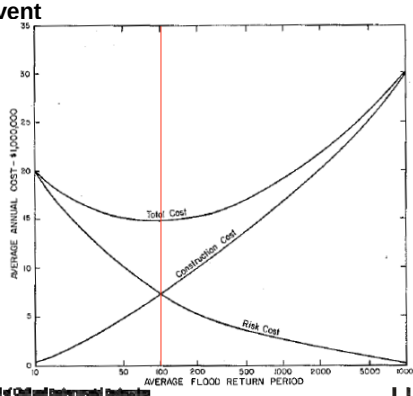
AS 4997-2005 Guidelines for the Design of Maritime Structures
Normal structure 50 year life: 500 year ARI
Residential development 100 year life: 1000 year ARI

FEMA USA AND AUSTRALIA FLOOD POLICIES for houses
100 year ARI plus freeboard of 0.3 to 0.5 m
NSW flirted with PMF (probable maximum) –OVERWRITTEN to 100 yr ARI

NETHERLANDS SW COASTAL DEFENCES: 10,000 year ARI

TASMANIAN BUILDING ACT: 100 yr ARI flood. 0.3 m freeboard

Design event



Setback planning and dune volume

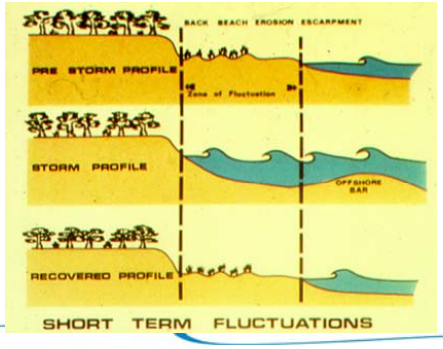
Setback components:

- S1: Allowance for storm erosion
  - (SBEACH modelling, Carley and Cox, 2003, 2 or 3 x 100 yr ARI design storms; or Gordon, 1987 stats)
- S2: Allowance for long term (underlying) recession
  - Photogrammetry, surveys (or judgment)
- S3: Allowance for beach rotation
  - ??
- S4: Allowance for reduced foundation capacity
  - (Nielsen, Lord and Poulos, 1992)
- S5: Allowance for future recession due to SLR
  - (Bruun Rule)

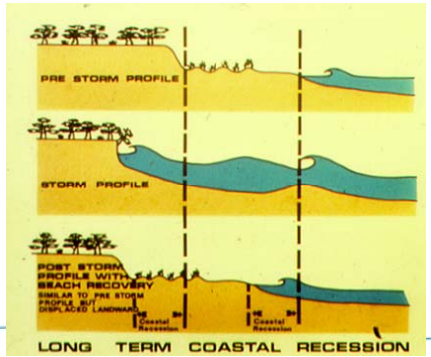
Collaroy-Narrabeen 1920

Collaroy beach front following the great storm of 1920. The surf club is visible in the background – *Faviell Collection*

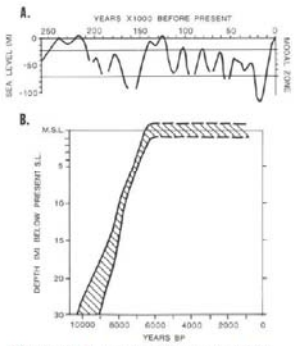
Erosion, accretion and recession



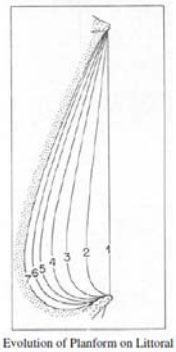
Erosion, accretion and recession



Recession – Zeta curve embayments

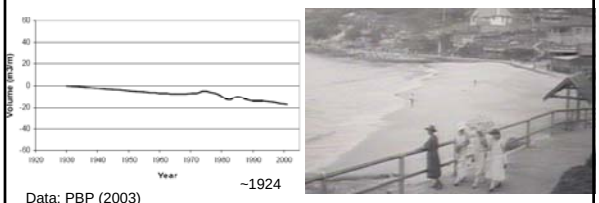


Historical Sea Level (Source: Chapman et al, 1982; Chappell, 1974; Thom and Chappell, 1975)



Evolution of Planform on Littoral Drift Coast (Source: Stephens, Roy and Jones, 1981)

Recession Fairy Bower Beach Manly



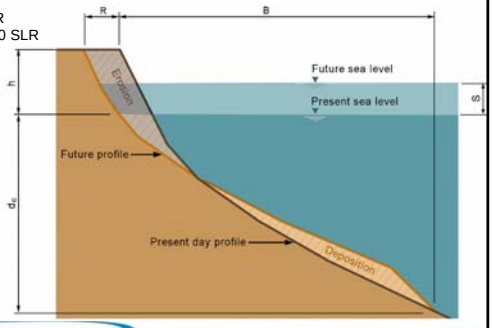
~1924

Data: PBP (2003)

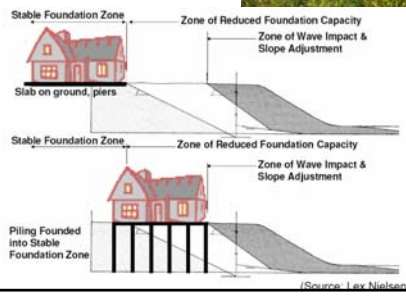
2005

Recession due to future sea level rise – Bruun Rule

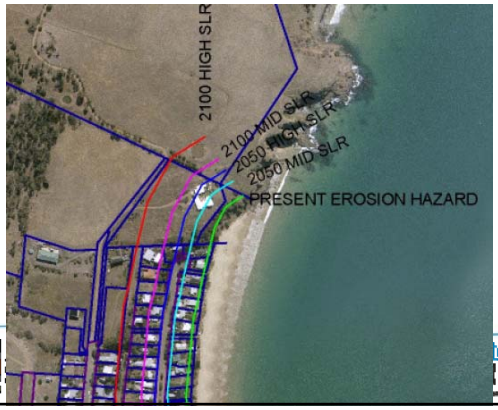
R = BF * SLR
= 50 to 100 SLR



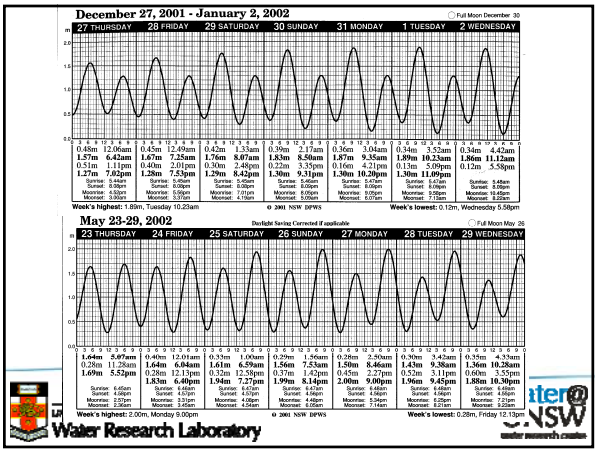
Dune foundation stability



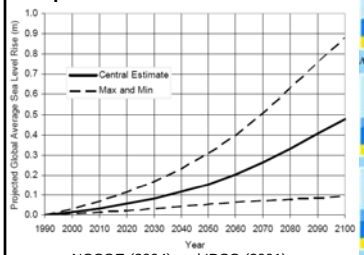
Hazard lines for buildings

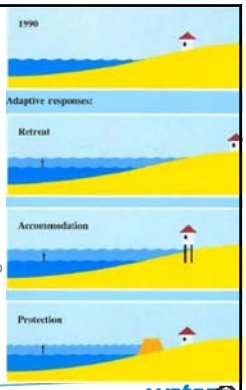


Beachfront house collapse Wamberal 1978



Adaptation and Sea Level Rise





NCCOE (2004) and IPCC (2001)

Adaptation = adapt to climate change
Mitigation = slow or stop climate change

Sea Level Rise Policies

State/body	Formal policy	Description/comment	Year	Sea level rise
NSW	NSW Sea level Rise Policy Statement (2009)	"up to"	2050 2100	0.4 m 0.9 m
QLD	Draft Queensland Coastal Plan (2009)	Planning period is based on anticipated asset life	2050 2060 2070 2080 2090 2100	0.3 m 0.4 m 0.5 m 0.6 m 0.7 m 0.8 m
VIC	Victorian Coastal Strategy (2008)	"at least"	2100	0.8 m
SA	Coastal Protection Board Formal policy		2050 2100	0.3 m 1.0 m
WA	WA Planning Commission Statement Of Planning Policy No. 2.6 State Coastal Planning Policy Prepared Under Section 5aa Of The Town Planning And Development Act 1928	The mean of the median model of the latest (2001) Assessment Report of the IPCC Working Group	2100	0.38 m from IPCC 2001
Standards Australia	AS 4997-2005 Guidelines for the Design of Maritime Structures	Cautions that IPCC findings are updated, with latest update to be considered	+25 yr +50 yr +100 yr	0.1 m 0.2 m 0.4 m
National Committee on Coastal and Ocean Engineering Engineers Australia	Guidelines for Responding to the Effects of Climate Change in Coastal and Ocean Engineering (NCCOE, 2004)	Suggested *engineering estimates* for application over the planning period to 2100 (based on IPCC, 2001 values).	2100 Min Central Max	 0.1 m 0.5 m 0.9 m
Department of Climate Change	Climate Change Risks to Australia's Coast: A First Pass National Assessment (DCC, 2009)	Plausible range of sea level rise values from post IPCC (2007) research	2100	0.5 m to 1.1 m

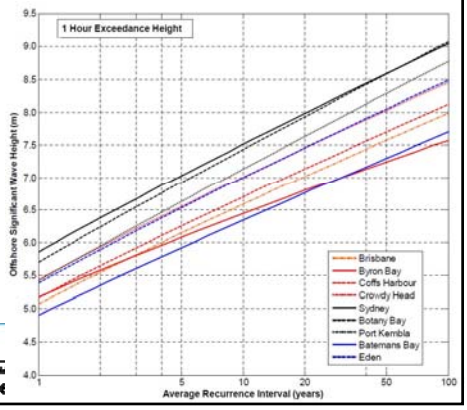
Storm waves

Collaroy-Narrabeen Beach, Sydney, March, 1976. Photograph: A. Short

Inundation during storm waves

Jonson St, Byron Bay, 1973. .K Dunstone c\ Byron Shire Council.

Extreme wave height

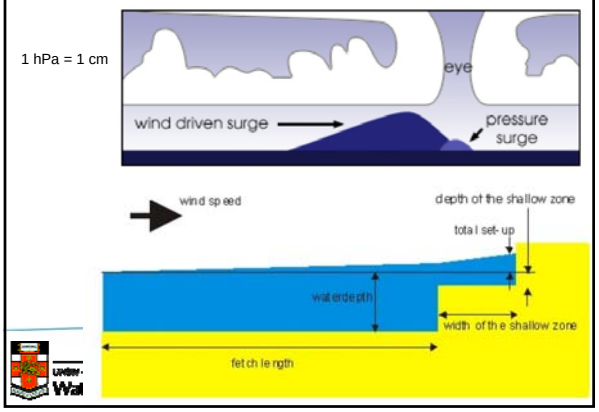


Inundation components

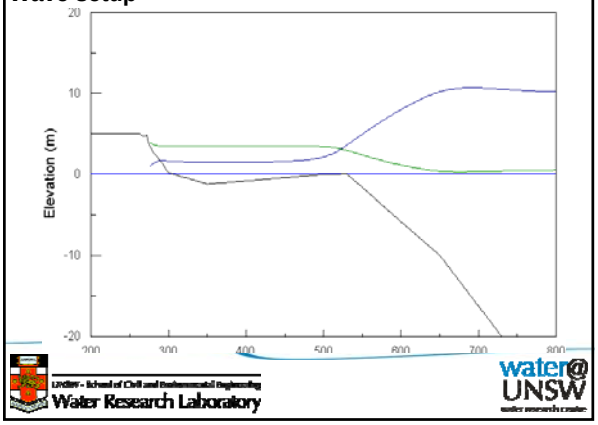
NSW open coast

Tide:	~2 m
Barometric setup	0.3 m
Wind setup (open coast)	0.3 m
Wave setup (open coast)	1.5 m
Wave runup (beaches)	2 to 5 m
Wave runup (cliffs)	up to 55 m
Sea level rise (2100)	up to 0.9 m

Barometric setup and wave setup



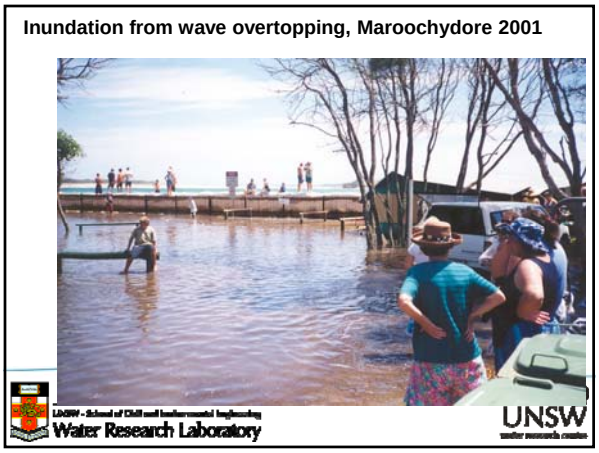
Wave setup



Wave setup

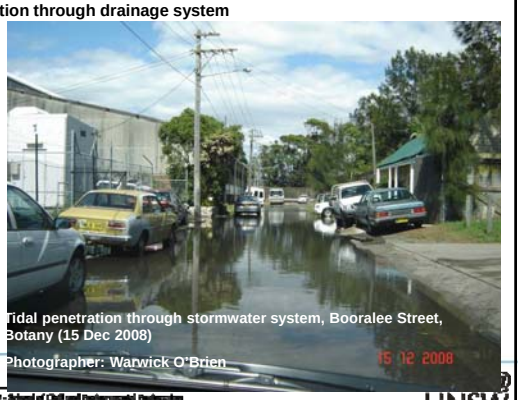
Overtopping, Maroochydore

Inundation from wave overtopping, Maroochydore 2001



Overtopping of Northern Breakwater, Coffs Harbour

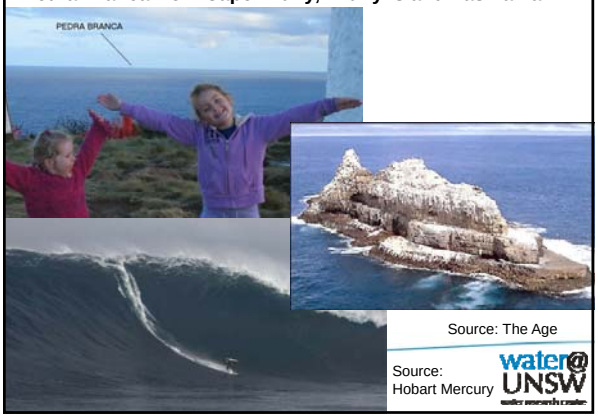
Inundation through drainage system



Tidal penetration through stormwater system, Booralee Street, Botany (15 Dec 2008)

Photographer: Warwick O'Brien

Pedra Branca from Cape Bruny, Bruny Island Tasmania



Source: The Age

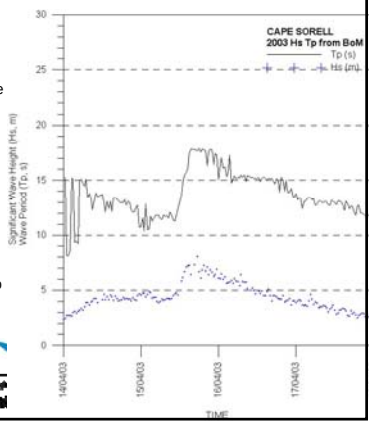
Source: Hobart Mercury

Wave runup on cliffs

Tasmanian Coroner Mathieson (2004) found that a man working on a scientific study was swept to his death by wave runup on Pedra Branca Island, Tasmania in April 2003 from an elevation of:
•45 m AHD

His three colleagues were threatened by wave runup and feared for their lives at:
•55 m AHD

There have been deaths due to cliff overtopping at Terrigal Haven (1974) and Tathra (1976)



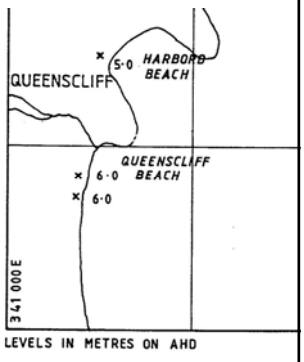
Wave runup on dunes August 1986 (WRL TR 88/06)

AUGUST 1986, SYDNEY
Debris lines surveyed by WRL
Good wave and tide data

PEAK Hs 7.5 m
(1 in 8 year ARI)
East at peak

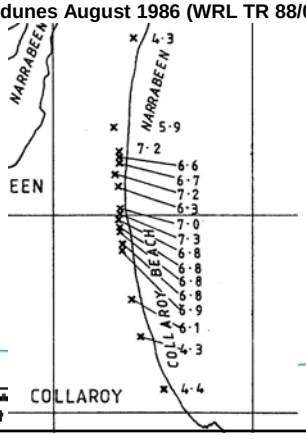
Hs > 3 m ~5 days

MAXIMUM SWL 1.17 m AHD
PEAK TIDAL ANOMALY 0.3 m

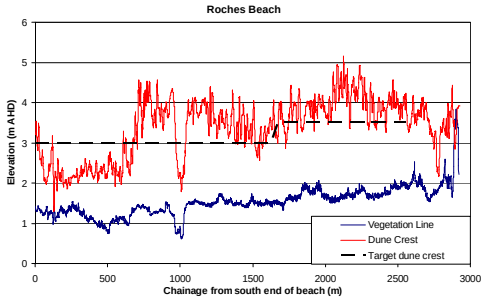


MAXIMUM RUN-UP LEV

Wave runup on dunes August 1986 (WRL TR 88/06)

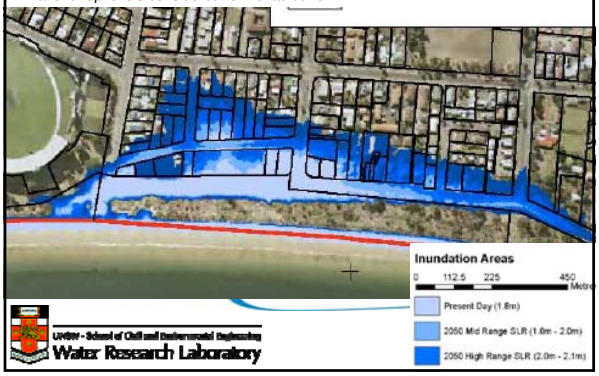


Potential dune overtopping



Potential Inundation LIDAR data

Inundation defined as: tide + barometric setup + wind setup + wave setup
Wave runup levels considered for frontal dune



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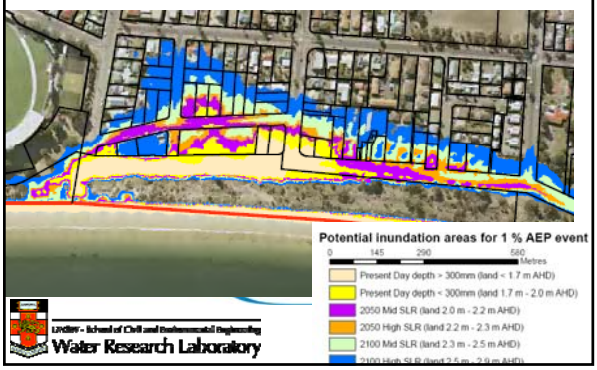

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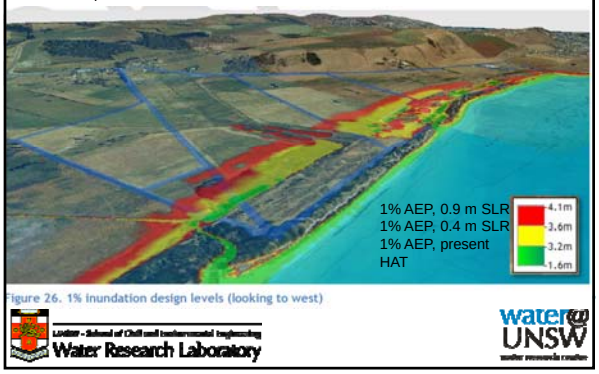

Figure 26. 1% inundation design levels (looking to west)

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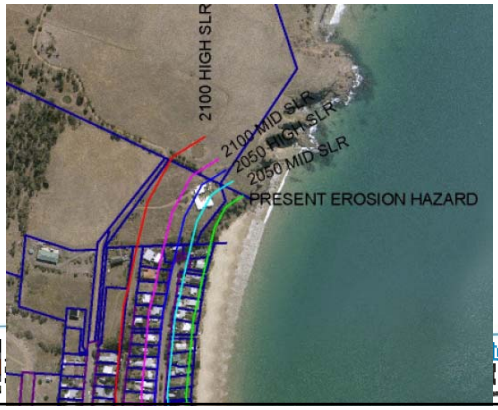
Hazard lines for buildings



Common mistakes

- Mixing up vertical datums – tide datum and AHD;
- Ignoring wave effects;
- Poor colour contrast;
- Too much effort on glossy output rather than studying or modelling processes;
- Sterilising otherwise viable land which may be inundated for 1-2 hours in 100 years if 0.9 m sea level rise occurs. This can be accommodated with floor levels or design life.

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Conclusions

- Up to five factors to consider for setback hazard lines
- Inundation hazard is considered separately to erosion
- Inundation needs to consider wave setup, and sometimes wave runup and overtopping, which can dominate for NSW
- Wave runup on cliffs can be extreme
- Complexities include:
  - Inundation through runup and overtopping
  - Inundation through the stormwater system

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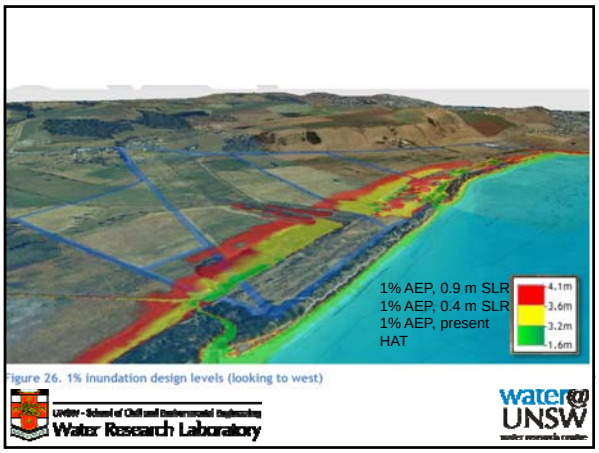

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